

# PATHFINDER

VOLUME 7 ISSUE 3

October 2000

An informal newsletter to the GPS User Community produced by Army PM GPS, Fort Monmouth, NJ. Information presented is based on published and submitted news items of interest to the general user. Widest dissemination and reproduction is encouraged and newsworthy items are solicited for inclusion. Editor Mr. Don Mulligan at PM GPS, Ft Monmouth NJ DSN 992-6137 or (732) 532-6137 or email: [Donald.Mulligan@mail1.monmouth.army.mil](mailto:Donald.Mulligan@mail1.monmouth.army.mil)

The Pathfinder can be found on-line at: <http://army-gps.robins.af.mil>

## PM's Corner



**Greetings from the Joint Program Office!** We continue to work very hard on the DAGR program, the next generation handheld GPS receiver. It takes

time but the final product will be worth the wait. We plan to introduce the DAGR to the Army in FY03.

This issue discusses the use of GPS and electronic mapping in the Army. We can only scratch the surface as this application of technology is still expanding. For example, Force XXI Battle Command Brigade and Below (FBCB2) is a new program that integrates data from many sensors including GPS to improve battlefield communications. Think of it as the Army's tactical internet, enabling "users" at all levels to exchange information and gain Situational Awareness of friendly and hostile forces.

When new technology develops there is usually a "shake-out" period when technical standards are established (remember the early competition between Beta and VHS format video cassettes?) The same thing applies to GPS and maps today as common technical standards are evolving.

The article titled "standardization & interoperability" explains why Precise Positioning Service (PPS) rated GPS equipment is essential. It could mean mission success versus mission failure.

If you have questions about today's or tomorrow's GPS receivers, contact me or any of my staff. See the POC list at the back of this newsletter!

LTC Eveland

## The “Big Picture”: We Want More!

A decade ago it was big news to hold a GPS receiver in your hand and see a 10-digit coordinate display of your location. Today, that is not enough. Now we want our position displayed on a user-friendly map of our surroundings, whether in an automobile navigation system or a military command & control system.

You can visit a car dealership and check out GPS-based navigation systems that typically combine GPS positioning with a database of street maps services and businesses. Some systems place a database CD in the car while others use wireless communications to connect you with an operator and a central database (“Batman, your airbag just deployed, should I send help?”).

Military applications are more demanding. In addition to our location on a map, we want to see a “real-time” dynamic display of the moving positions of friendly and hostile forces. We also want the intelligence & logistical data necessary to provide “information dominance” on the battlefield! A static database of streets, etc won’t do!

A discussion of the Fire Control or Command and Control systems that bring this information together can be complex. For our purposes, we will briefly discuss the GPS and mapping elements common to most systems: The GPS receiver, the digitized map and the computer program that brings them together. We hope these articles improve your understanding of where GPS and maps are today and where they are headed in the future.



### The GPS Receiver.

Since GPS is still a “new” technology, there has not been time to develop bad habits (like using commercial GPS receivers!). The standard PPS-rated GPS receiver today is the AN/PSN-11(V) Precision Lightweight GPS Receiver (PLGR). Designed for handheld use, the PLGR is also often used to supply GPS data to various computer-based systems including those with map

displays. When operated with the COMSEC key, PLGR provides consistent accuracy and incorporates anti-spoof and anti-jam protection. For this reason, PLGR is the GPS receiver to use for combat or combat support operations. In the future, the next generation handheld receiver, Defense Advanced GPS Receiver (DAGR) will join PLGR in the field. DAGR technology will also be available “without a body” called the GPS Receiver Applications Module (GRAM). The GRAM will come in several physical shapes so that one of them will be “just right” to fit in the available space of a weapons system or host computer. With PLGR today and DAGR or GRAM tomorrow, there will always be a consistent standardized level of GPS receiver performance available for military operations.



### The digital map.

Unlike the “new” technology of GPS, map making has been around for thousands of years.

Since maps were traditionally created to suit whatever purpose the customer wanted, scale, formats, contents and details varied widely. For example, a highway map looks very different from a military terrain map. With the arrival of digital technology, it became possible to record and store a “map” in a computer. A software program could then use this “map” for automated navigation (e.g. cruise missiles). It became apparent that in an age of computer-shared mapping data, our existing collection of non-standard paper map products was obsolete. In 1996, the Defense Mapping Agency (DMA) was rolled into the National Imagery and Mapping Agency (NIMA) to address the evolving requirement for digital maps and images.

An interesting detail: DIGITIZED maps are those created by scanning paper maps while DIGITAL maps are those created directly in digital format.

NIMA is working on both: Digitized maps are created when an optical scanner records an existing paper map in a digital file which can then be displayed as an image. However, a scanned map can only reflect the accuracy of the paper version. Scanning doesn’t

“correct” any existing errors. By comparison, digital maps are “new” since they are created when a high-power computer is used to survey the position coordinates of every feature in a given area. This data can be shown as a flat map or a “really cool” 3-D display. Unfortunately, this true digital map is not yet common due to the large computer capacity required to host it. Nevertheless, with Digitized and Digital maps, NIMA is moving us towards a future of standardized military mapping.

And nothing is ever easy: There are other issues to consider. Do we get the same quality of maps when working with aeronautical charts, satellite imagery or topographic elevations? What scale is desired versus affordable (scale drives the computer memory requirement). And we still have to deal with the “old problem” of datum: Have you selected the correct datum in your GPS receiver setup and is everyone on your mission using maps with the same datum?

A step towards standardization occurred when the Chairman, Joint Chiefs of Staff established World Geodetic System 1984 (WGS 84) as the standard position reference system for military operations. (CJCSI 3900.01A dated 10 Aug 98), This made WGS 84 the official datum for military use and strongly recommended that only maps with WGS84 be used in military operations.

We are not there yet with regard to standardized maps but with NIMA as the official source for military digital mapping we are headed in the right direction. (There is more information about NIMA in a following article).



### **The computer program that puts it all together.**

If the use of a keyed PLGR provides standardized GPS and maps are becoming more standardized thanks to NIMA, what about the operating software that combines them? It remains the least standardized of the three elements but there are several reasons why.

First, there is no single DoD office responsible for developing navigation

software. As a result, program developers buy commercial mapping software that is compatible with their primary system. Second, each program must tailor the software to put GPS and map information at the right place to support their larger mission. Third, the military has unique system requirements that don't exist in commercial mapping software systems (e.g. the ability to display moving locations of friendly and hostile forces).

As a result, each fire control or command & control system has customized software. This makes it essential that the “building blocks” of GPS and map data come from the same sources so that all battlefield systems, regardless of “customized” software are “reading off the same map”. With a keyed PLGR and a NIMA map, two of the three elements are as close to standardized as possible.

The use of GPS and digital maps has come into the Army from different directions with different sponsors and combinations of hardware and software. Although it appears to violate the concept of standardization and interoperability, it reflects the reality of a fast-moving technology where the integration of GPS and digital maps is still a moving target (no pun intended).

### **Conclusion:**

Using PLGR in PPS mode makes GPS the most standardized of the components in any GPS/mapping system today. As NIMA develops digital maps, that element will also become standardized. Variations in operating system software will remain since each is focused on a different primary objective.

### **Modernization is the “Next Big Thing” in GPS:**

As the lead service in the GPS program, the USAF recently awarded a \$53M contract to accelerate the modernization of GPS satellites. So what you say? Today's GPS system is based on the original 25-year old designs. That's pretty good for the digital age where obsolescence can occur within 5 years!

The Modernization process is the first major upgrade to the GPS program. It will upgrade technology to improve civil and military accuracy, integrity, availability and coverage. It includes protection for Allied users (new countermeasures for jamming and spoofing protection) and prevention of GPS use by any adversary with minimal disruption to civil users outside the Area of Operations.

The contract award means the soon-to-be-launched Block IIR satellites will get some of the “modernization technology” years sooner than previously planned. When all of the Space and Control Segment upgrades are in place and the next generation of GPS receiver technology is in the field (DAGR, GRAM, etc) the entire system will shift over to the new technology.

*Del Crane at TMD*

## **What is NIMA?**

The National Imagery and Mapping Agency (NIMA) was formed in 1996 by consolidating the Defense Mapping Agency with seven other organizations involved in imagery. This action established NIMA as the single source for military maps. NIMA’s goal is to provide timely, relevant and accurate imagery, imagery intelligence and geospatial information in support of our national security objectives.

What is geospatial information? It is information about any natural or man-made object that can be referenced to a specific location on the earth (e.g. the low point of the Grand Canyon or the top of the Empire State building). It can take many forms including mono and stereo imagery, maps, charts or navigational aids (paper or electronic medium), terrain elevations, geophysical data (e.g. magnetic variations), nautical and aeronautical safety information.

While NIMA continues the project of converting existing paper maps to digital form, it is also working to get information for new maps. A recent Space Shuttle flight recorded high-resolution imagery for use in NIMA maps.

NIMA’s work will never be “done” since it is always necessary to periodically update maps to reflect changes as features are added and bridges are built. Remember what happened when the map used for a cruise missile attack in Kosovo was not updated to show the new location of the Chinese embassy? Another source of change in maps is nature which creates shifts known as magnetic variations (MAG VAR). You will always need a CURRENT map for your Area of Operations.

For more information about NIMA, visit their web site at <http://www.nima.mil> or contact them at DSN 490-5032 or 1-800 455-0899.

## **“Standardization and Interoperability”**

All military forces should “read off the same sheet of music”. Remember the situation in Haiti when aviation and ground forces could not communicate due to incompatible radios? The general rule is “standardize whenever possible” so systems sharing a interoperable and can communicate with each other when they have to.

For GPS, all military systems should refer to a location with the same predictable level of accuracy using the same geospatial position references (datum and grid). Standardization is obtained by using a GPS receiver in the Precise Positioning Service (PPS) mode. PPS provides a specified level of accuracy and anti-jam and anti-spoof protections. And a JPO-approved receiver means you have a high likelihood for interoperability because all PPS-rated GPS receivers comply with the Interface Control Document (ICD) that standardized all GPS input/output data formats.

By comparison, the accuracy of commercial GPS receivers varies by design and there is no guarantee they will work under hostile EW influences since most don’t address the potential for spoofing and jamming interference.

In 1992, the Secretary of Defense (SoD) issued policy to direct that only PPS-rated GPS systems be used for combat or combat support operations. This set the PPS standard for military receivers. In 1996, the National Imagery and Mapping Agency

(NIMA) was formed to standardize the production of military maps. In 1998, the Chairman, Joint Chiefs of Staff (CJSC) published guidance that military operations use WGS 84 as a common reference system. In 1999 and again in 2000, the SoD reiterated the critical need that only PPS systems be used for combat and combat support operations. Together, these actions underscore the need for "standardization and interoperability".

In the future, the Army may migrate to a common digitized navigation system for all forces. Only when all services use common GPS and mapping systems will true battlefield interoperability be achieved. Until then, the use of a keyed PLGR in PPS-mode is an important step towards interoperability.



*The Paladin display/control panel is a good example of a customized system suited to meet the need of the fire control system for this self-propelled howitzer system. It draws GPS data from the PLGR (just out of view)*

### **Do any Army programs use GPS and digital maps today?**

Yes, many programs use PLGR to supply GPS data. A few years ago some Army programs tried commercial GPS receivers but soon discovered their weakness and lack of anti-spoof and anti-jam protections. Today, everyone recognizes the mandate that only PPS capable systems (like PLGR) be used in combat and combat support operations.

In the future most of these programs will replace PLGR with DAGR or GRAM to maintain PPS-rated GPS systems compliant

with new GPS security technology which is coming as a result of the GPS Modernization Program.

A number of "personal navigation systems" have been developed and tested for military use. One combined GPS with Dead Reckoning for dismounted soldiers; another combined GPS with an inertial navigation system for a weapon platform. And now that NIMA maps are becoming available, many systems will use them to replace the commercial maps they currently use.

Most of these "demonstration technologies" have found their way into the GPS navigation element of new systems such as Land Warrior, FBCB2 or Movement Tracking System (MTS). As these programs go through field demonstrations, the advantage of having "real-time" information on the battlefield always outweighs the physical weakness of the hardware. Ask a participating soldier and the usual answer is "this will be great - once they ruggedize it!"

Despite the wide variation in the purpose of these systems, they share a common technical challenge: How to cram enough computer memory into the system to accommodate high definition digital maps. Land Warrior, FBCB2, MTS and others are each working on this problem. Sometimes the map area can be reduced or a lesser detail accepted. But a lesser map density precludes the ability to zoom in for greater detail. The capability of the host computer also affects the speed with which the display can be "refreshed" to update a view with new information. These issues will shake out over time as digitization programs come through their test and development phases and enter Army service.

The USAF has developed the Portable Flight Planning System (PFPS) for aircraft mission planning. PFPS is tailored to USAF missions and can get complex but there is an interesting component called Falcon View that uses NIMA maps in a big way. Falcon View allows a planner to sit at a work station and "point and click" on a map to create a waypoint file. It also allows data overlays so you can impose mission information over the map image. One agency is working to make this feature

exportable to Army PLGR users! When they have something ready to share we will be sure to report on it.

In the Army, PM Paladin was one of the first systems to use PLGR for GPS data. Paladin used GPS positioning to place the Paladin howitzer and to identify targets using Firefinder radar. It displayed information on a screen using various indicators, not a map. As technology has advanced, Paladin is now replacing the original monochrome screen with a "smart" full color display. This allows Paladin to introduce graphics and a map display and integrate to the emerging FBCB2 program for situational awareness.

Each of these programs uses PLGR as the source of standardized GPS data. To a lesser extent they are using standard NIMA data when it is available in the right format and when their host program can accommodate the NIMA files. Each passing month brings growth in computer chip processing and storage capabilities, critical to getting computerized maps into very small packages.

Computer-based navigation systems using GPS and digitized maps will continue to mature into rugged "soldier proof" field systems. And standardized GPS data and NIMA maps will increase the likelihood that programs using this data will be fully interoperable with other battlefield systems.

The Point of Contact for how GPS technology is being used by other Army systems is the Technical Management Division (TMD) at the Los Angeles CA office. You can reach them at the POC list at the rear of this newsletter.



*The FBCB2 program is a typical use of PLGR to provide GPS to a computer-based navigation and mapping system today. On the right is the PLGR connected to the vehicle for power and the computer for output. On the left is the computer and display of the FBCB2 system.*

## **What are the basics of integrating GPS with a map?**

The PLGR data interface can transfer GPS position, ground speed, track, etc to a digital map display. If you wish to integrate a GPS receiver with a digital map system, be sure the interfaces are compatible in terms of:

- Electrical characteristics
- Functional characteristics
- Data format
- Data update rate

A digital map scanned from an existing paper map can be no more accurate than the source paper map. Additionally, any inaccuracies in the optical reader system and operator-induced errors can add up to a total discrepancy greater than any original map inaccuracy. (Some paper maps used for navigation today are based on surveying data that is 80 to 100 years old! Check the date in the margin of the map you are using!) The age of the mapping data is a generally a good indicator of its accuracy.

The GPS receiver and the map must reference the same datum! Using the PLGR menu you can select the map datum from a long list of choices and the PLGR will convert the WGS-84 data into coordinates appropriate for that datum. If a map and PLGR are not referenced to the same datum, there can be a position difference of up to 1,000 meters!

Get technical assistance from TMD!

## **SAGR Post Warranty Repair Support**

A contract providing post-warranty repair support for the AN/ASN-169 Standalone Air GPS Receiver (SAGR) was recently signed with Trimble Navigation Ltd. The contract ensures that SAGR being used by Army aircraft can be repaired as needed. SAGR was originally used as an interim GPS set by overseas aircraft and is now being used by selected aircraft located in CONUS. If you are an authorized SAGR user, repair return procedures are unchanged. If you have any questions, contact PM GPS at DSN 992-6134/6136 or CECOM at DSN 992-9153.



### Got an old SLGR in the back room?

SLGR is the original "Desert Storm" era handheld GPS receiver, no longer authorized for use in combat or combat support operations. SLGR was replaced by the PLGR and it should not be maintained in any deployable unit. Any remaining SLGR (not to be confused with the very similar SAGR) should be returned to the address provided below.

#### NSNs for SLGR:

5825-01-356-7849  
5825-01-357-5506  
5825-01-357-6170  
5825-01-357-6171

#### Return them to:

NewTec  
Bldg 91302 (Avionics Lab Annex)  
Attn: Steve Robinson  
Ft Huachuca AZ 85613

*Steve Robinson*  
DSN 879-2877

### How to Contact PM GPS

Army PM GPS has offices in California, Georgia and New Jersey under the direction of LTC Eveland who is located at the Los Angeles Air Force Base. Email sent to any of these contacts will be forwarded to the right office for reply.



For PM GPS and the Technical Management Division (TMD) at Los Angeles, CA call (310) 363-0595 or DSN 833-0595. Email:

[del.crane@LOSANGELES.AF.MIL](mailto:del.crane@LOSANGELES.AF.MIL)

For the Georgia Field Office (GFO) at Warner-Robins, GA call (478) 926-3288 or DSN 468-3288. Email:

[johnny.walker@ROBINS.AF.MIL](mailto:johnny.walker@ROBINS.AF.MIL)

For the Readiness Management Division (RMD) at Fort Monmouth, NJ call (732) 532-4733 or DSN 992-4733.

Email: [james.buggy@mail1.monmouth.army.mil](mailto:james.buggy@mail1.monmouth.army.mil)



### Who to Call?

For new technical installation advice, new product information (SAASM, DAGR) technical test reports and acquisition support planning, call TMD.

For sustainment management including software support, supply support, technical publications and accessory procurement, call GFO.

For fielding, equipment authorizations, host vehicle installation assistance and New Equipment Training, call RMD.

Pathoct00-4



## PATHFINDER

PM GPS  
Attn: AMSEL-DSA-GPSR  
Squier Hall  
Fort Monmouth, NJ 07703

ACCT #89

**FIRST CLASS**